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# Rapid and Long-term Measures for Prevention and Mitigation of Communication Barriers in Production Networks

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## Abstract

Due to the constantly increasing complexity and dynamic of modern production networks within value chains, effective communication between the individual corporations is required. Communication barriers, can lead to delays in the value creation process, which can lead to losses of efficiency in the entire production network. Within the framework of "InterKom", a joint research project of the WISSENSARCHITEKTUR Laboratory of Knowledge Architecture at TU Dresden and the Institute for Factory Systems and Logistics at Leibniz University Hanover, corresponding measures were developed on the basis of previously identified communication barriers in the context of production networks. These insights can be used to prevent communication barriers between suppliers, producers or consumers or to mitigate them as soon as they occur. The aim of the project is to provide a catalogue with precautions and countermeasures for corporations that supports the removal of communication barriers in the future.

## Keywords

Production Network; Communication; Communication Barriers; Precautions; Countermeasures

## 1. Introduction: The Role of Communication Barriers in Production Networks

Communication is a decisive core competencies of networked corporations [1] and needs to be included as a key factor in new production factor systems [2]. According to BRUHN, communication in the context of production networks, serves for internal agreement-finding between departments and employees within a corporation, as well as for external consultation with customers [1] or different corporations at different locations, which according to RUDBERG and OLHAGER can be categorized as an "internal network" [3]. Especially in production networks in which information between collaborating corporations flows in both directions – upstream and downstream – along the value chain, [4], inter-organisational processes must be coordinated by consistent communication. Delays or false transmission of information at some communication interface can be called "communication barriers". According to SHANNON, a communication barrier can be defined as an obstacle between the transmitter and receiver of a communicative exchange [5]. Errors, that occur through a communication barrier, continue upstream or downstream and can lead to a slowdown of the entire value creation process - a phenomenon that is called "bullwhip effect" [6] [7]. According to LEE et al., causes of the bullwhip effect are updates of the demand forecasting, order batching, price fluctuation or rationing and shortage when product demand is too high [8], as well as lead times [9]. This vulnerability of the value creation process of manufacturing corporations by communication barriers requires what RÖHNER & SCHÜTZ call "communication competence" [10] – only thus error transmission can be avoided in advance, and occurring communication barriers be mitigated timely.

## 2. Framework: A Descriptive Model to Identify Communication Barriers

In the framework of "InterKom", a DFG-funded research project of the WISSENSARCHITEKTUR Laboratory of Knowledge Architecture at TU Dresden and the Institute for Factory Systems and Logistics at Leibniz University Hanover, communication barriers and corresponding generic measures for avoidance and mitigation in the context of production networks were collected. Especially in non-physical spaces, MOESLEIN sees a need for the visible and tangible in an "initially largely invisible world of information" [11]. In this context, "InterKom" presents a descriptive model that maps the communication between employees of different departments or corporations by so-called "communication paths" [12]. The descriptive model distinguishes between different layers, which can localise the communication barriers in the overall structure of the value chain, as shown in Figure 1.

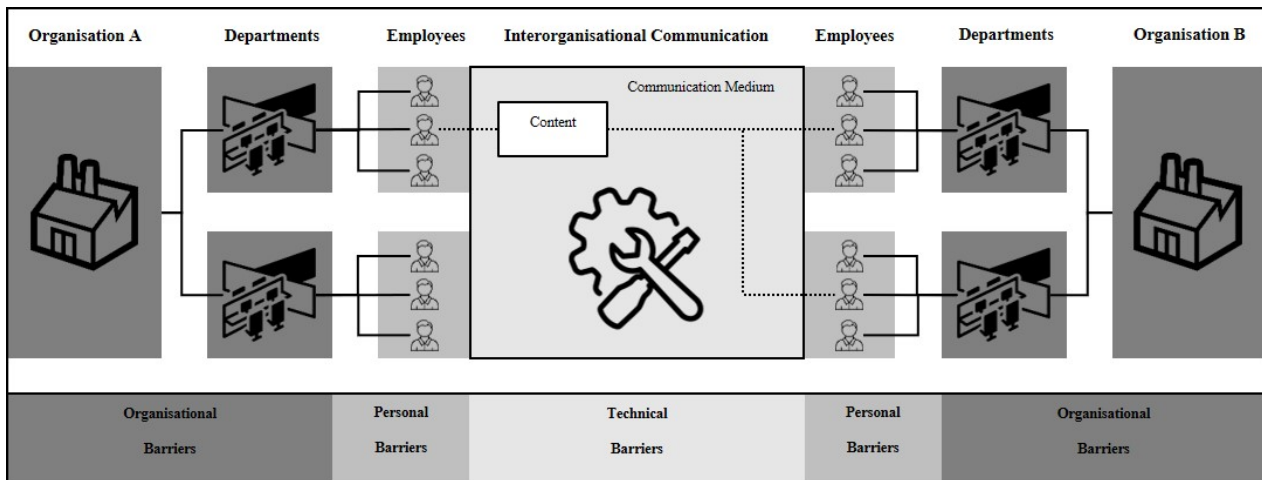


Figure 1: Descriptive Model of Communication Paths within a Production Network

On the first layer (Organisation Layer) the organisational classification of the corporation is carried out in the overall structure of the production network. Here, communication interfaces appear within a corporation (intra-organisational) and between corporations of a production network (inter-organisational) [13]. The second layer (Responsibility Layer) represents the organizational assignment of responsibility areas of the corporations that communicate within the production network. Here, communication interfaces appear within an area of responsibility, such as a department or sub-department, at (intra-departmental) or between different departments (inter-departmental) layer. The third layer (Operative Layer) considers the employees of a department or sub-department of an organization. It thus represents the smallest possible scale in a production network, which is necessary to localise and characterize communication processes. The fourth layer (Communication Layer) describes the medium [5] of the communication object to be transmitted in a communication context [14] between sender and receiver according to SHANNON, which can basically be divided into visual media (e.g. letter, e-mail), auditory media (e.g. telephony, voice messages) and audiovisual media (e.g. video telephony, face-to-face) [11]. In order to analyse inter-organisational production networks, the focus of the communication barriers should be on the communication paths that take place between the same or different departments of different corporations. Examples are the communication between suppliers and producers, or the communication between end customers and producers.

### 3. Problem Description: Measurement of Communication Barriers in Production Networks

Communication barriers in production networks can occur in corporations at all formal and informal communication interfaces [15] between sender and receiver. Formal communication can be understood as everything that is involved in processing the product to be produced, such as order confirmations, material orders or price negotiations. Formal communication thus follows the formal structure or hierarchy of the corporation [16] and, since it takes place explicitly, can be identified by theoretical and empirical means. In contrast, there are very few theoretical models and empirical studies on informal communication. WAGNER cites as a reason that informal communication usually leads to the transmission of confidential information, the exchange of which is based on trust and secrecy and the transmission of which would be critical [17]. Informal communication channels such as grapevine and gossip can often fill the gaps left by formal communication [16]. Examples include recommendations from partners, discounts in price negotiations or the transmission of confidential information. The importance of communication within corporations, especially via information and communication technologies (ICT) requires, according to LUO & BU, the three interrelated elements of access, search and codification as well as a „significant attention for not only theoretical advancement but also practical implementations“ [18].

The focus of "InterKom" is on inter-organisational communication (formal and informal) between corporations that have joined forces to form a common value chain. The constellation shown in Figure 1 is thus to be examined according to the descriptive model explained above, i.e. by using communication paths: On the Organizational Layer, communication takes place outside the corporation; on the Responsibility Layer, communication takes place inside or outside the department; on the Operational Layer, communication barriers are identified. For identifying communication barriers, as a first step, general communication barriers as well as barriers in production environment were compiled by literature research, e.g. WIK-WAH FONG & CHU [19], NIIMINÄKI et al. [20] and GRANHAGEN JUNGNER, et al. [21]. In the next step, all collected communication barriers were validated in qualitative interviews and surveys by representatives of industries working in the field of logistics, production or distribution as part of a value chain; they either confirmed or classified certain communication barriers as irrelevant. Also, they added further communication barriers to the list, if such occurred in their environment and were not yet mentioned in the literature research. The communication barriers validated that way could be assigned to three different causes, which also represent the classification of communication barriers in the following sections: 1) organisational, 2) personnel and 3) technical communication barriers. Organizational communication barriers comprise all processes that deal with the overarching coordination of the value creation process, such as the responsibility of employees for certain activities. As shown in Figure 1, the cause of organisational communication barriers can primarily be found in the administration, i.e. on the organisational layer of the descriptive model. Organisational communication barriers are, for example, lack of standard processes, unclear responsibilities or unclear decision-making power. Personnel communication barriers comprise all processes that can be attributed to personal concerns, abilities and deficits of employees, such as different mother tongues, use of technical language, or use of "insider-terms". Causes for personnel communication barriers can primarily be traced back to the human factors [22] of employees at the responsibility level, such as the personal expertise, abilities and weaknesses of individuals. Technical communication barriers include all processes that are dependent on technological aids and exclude human factors. Thus the cause of their occurrence lies neither in the administration nor in the employee, but on the communication level, which includes the medium of communication. Technical communication barriers include, for example, poor local infrastructure, poor transmission quality or large spatial distances.

#### 4. Approach: Rapid and Long-term Measures for Prevention and Mitigation of Communication Barriers in Production Networks

The next step in the InterKom project was to collect measures for the communication barriers described above. First, approx. 20 generic measures in the context of production networks and other domains were collected by literature research. Subsequently, representatives from industries active in logistics, production or distribution as part of a value chain were shown the previously collected communication barriers in a qualitative survey. About 25 measures were formulated by the participants for all communication barriers which play a role in their environment and which affect them in their working routine. It could be observed that most of the measures mentioned are theoretical recommendations, but are not practically applied in the corporation. The next step was to list the measures collected from the literature and to let representatives indicate which measures were relevant or applicable to their own working environment. A validated catalogue of generic measures could be derived from this. Below is a selection of generic measures with their corresponding classifications:

Table 1: Selection of classified Precautions and Countermeasures for Communication Barriers

Precautions / Countermeasures	Rapid Implementation	Long-term Implementation	Prevention	Mitigation
Training of employees who communicate with foreign-language customers/partners		x	x	
Integration of native speakers/interpreters		x		x
Transmitter (who knows both cultures)		x		x
Qualification: for example through team trainings		x	x	x
Technological aids e.g. language software	x		x	x
Active listening: Explain facts to others in order to understand them better	x		x	x
Translation into easy language	x			x
Definition of standardised processes, formats and procedures		x	x	
Direct Mailing	x		x	
Definition of minimum requirements for documents	x		x	
Periodic checking of the up-to-dateness of electronic tools		x	x	
Implementation of a Wiki (knowledge store + definitions)		x	x	

As shown in Table 1, measures collected from respondents as well as from literature could be classified in two ways. The first classification distinguishes measures that can be applied rapidly when a communication barrier occurs in the corporational environment from those requiring a lead time for implementation. For example, a change of communication medium can take place immediately, whereas the introduction of

standard processes requires a lead time within a department or the entire corporation. The second classification distinguishes between measures that either prevent communication barriers as precautionary measures or reduce them as countermeasure in case of already occurred communication barriers or both. For example, periodically checking the up-to-dateness of electronic devices can prevent their susceptibility to errors, whereas language software can reduce a lack of language skills.

## 5. Findings: Consolidation of Communication Barriers and Precautions / Countermeasures

In a last step, the validated communication barriers were juxtaposed to validated precautions / countermeasures. According to ANDERSSON, these measures should aim at implementing routines [23] that prevent or mitigate communication barriers. As shown in Figure 2, one or more suitable measures were assigned to each communication barrier (arranged according to organisational, personal and technical aspects). For the representation, 15 arbitrary communication barriers were selected from the previously validated barriers.

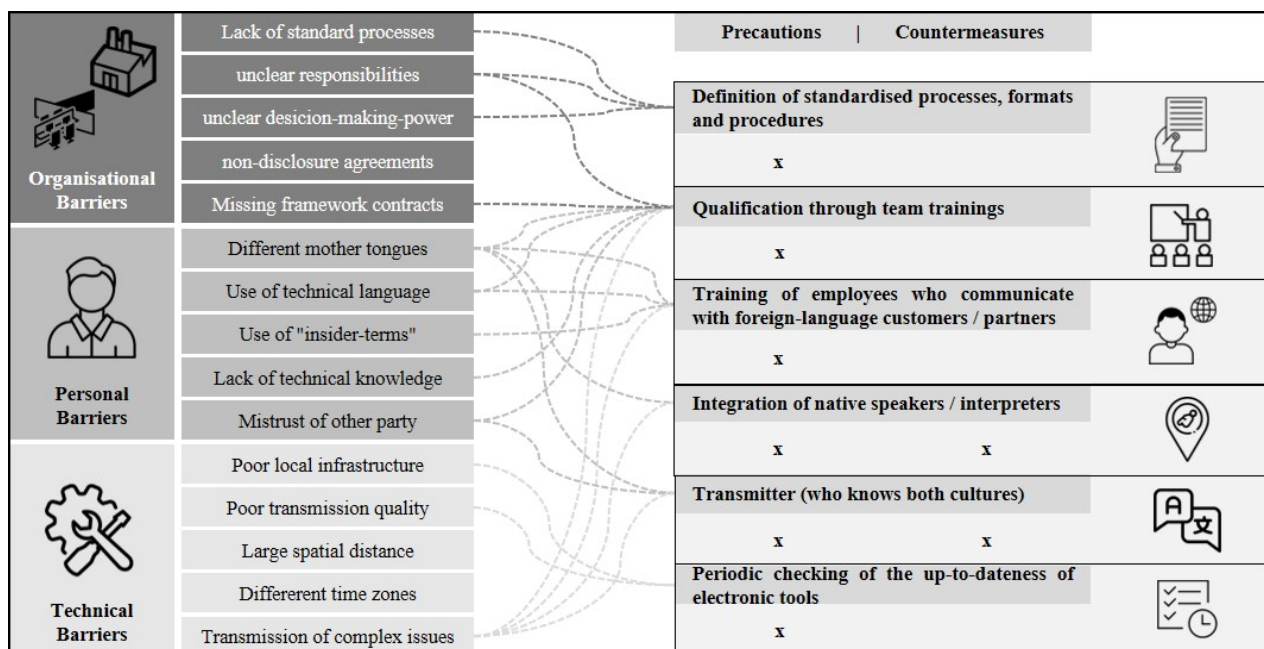


Figure 2: Exemplary linkage of communication barriers with validated precautions / countermeasures

The selection of the 15 communication barriers shown makes clear that measures can usually be applied to several communication barriers. They can also be applied across all layers, for example by training teams to clarify unclear responsibilities (organisational barriers) or by helping out with lack of technical knowledge (personal barriers). However, it should be noted that it was not possible to find suitable measures for every communication barrier up to this point of the research project. For the practical avoidance and mitigation of communication barriers in the context of production networks, an iterative approach is required, as shown in Figure 3.

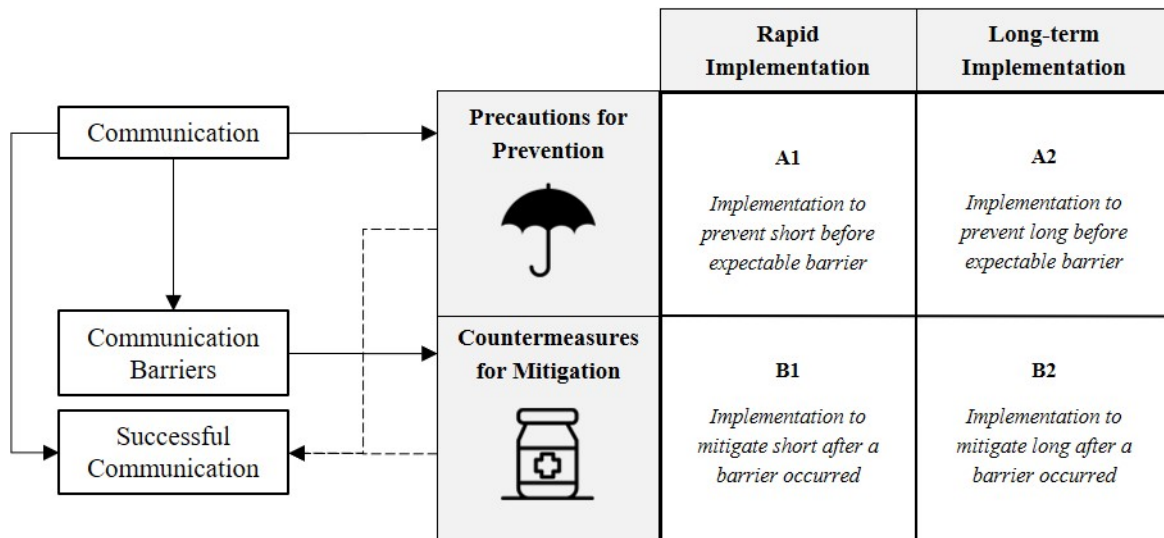


Figure 3: Iterative approach between communication barriers and precautions & countermeasures

The aim of communication is to ensure smooth and secure transmission of information without barriers, for both sender and receiver. If a barrier occurs during communication between sender and receiver, corresponding countermeasure must be initiated. Depending on the classification of countermeasure, it can be initiated rapidly (B1) or with delay (B2). The latter can be used if the communication barrier causes a longer after-effect, such as a poor local infrastructure. If the short-term and long-term countermeasures lead to successful communication, the sender and receiver usually learn and acquire knowledge. These insights can be used to initiate precautions to prevent communication barriers in advance. In this case, they can be used rapidly (A1) or with a planned lead time (A2). It is recommended that measures A1 and B1 be implemented whenever possible (by low efforts). Measures A2 and B2, on the other hand, should be used if there are serious communication barriers that are to be expected or have occurred in the past.

The list of precautions and countermeasures for previously validated communication barriers is constantly being expanded within the framework of InterKom, targeting at a comprehensive catalogue of measures that companies can implement in their daily work routines.

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